Exploring Mars in Three Dimensions:

Classroom Activities and Lessons on Mars Exploration

by David V. Black
Walden School of Liberal Arts, 2011
elementsunearthed@gmail.com

http://elementsunearthed.com/downloads

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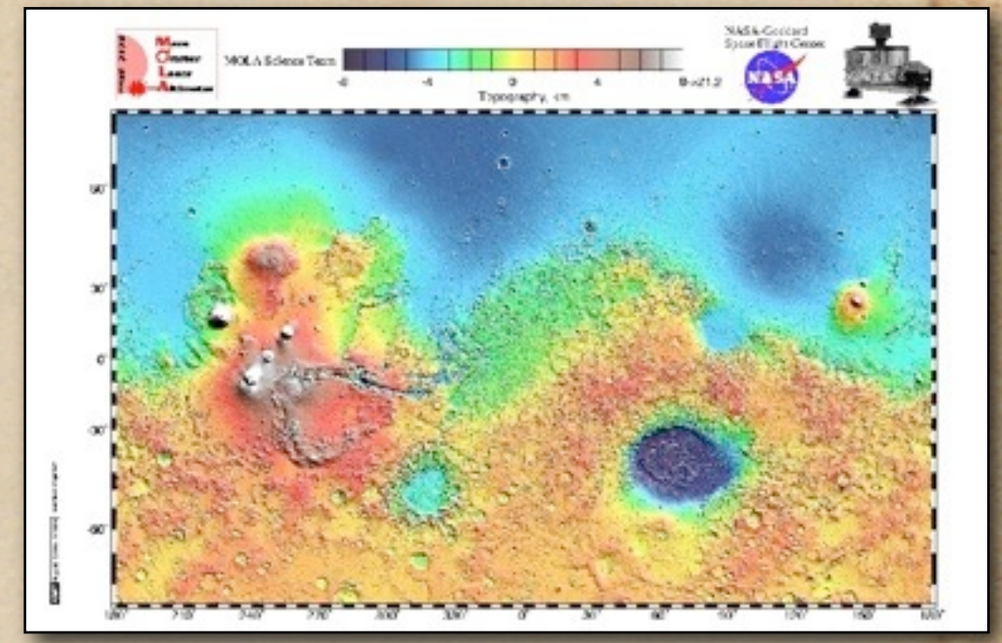
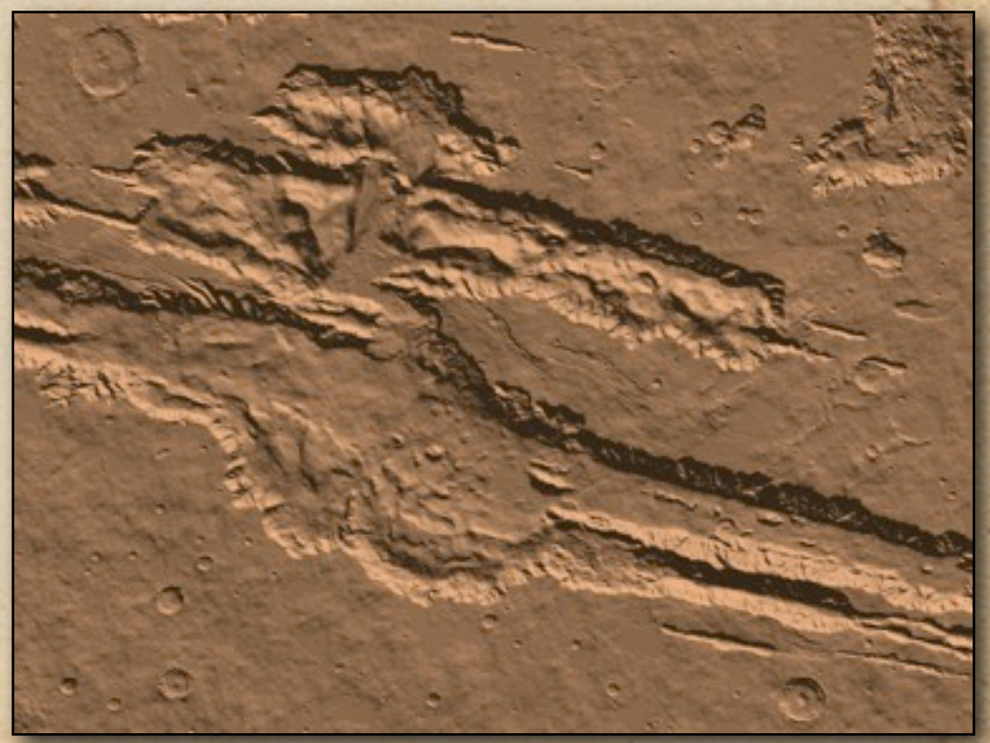
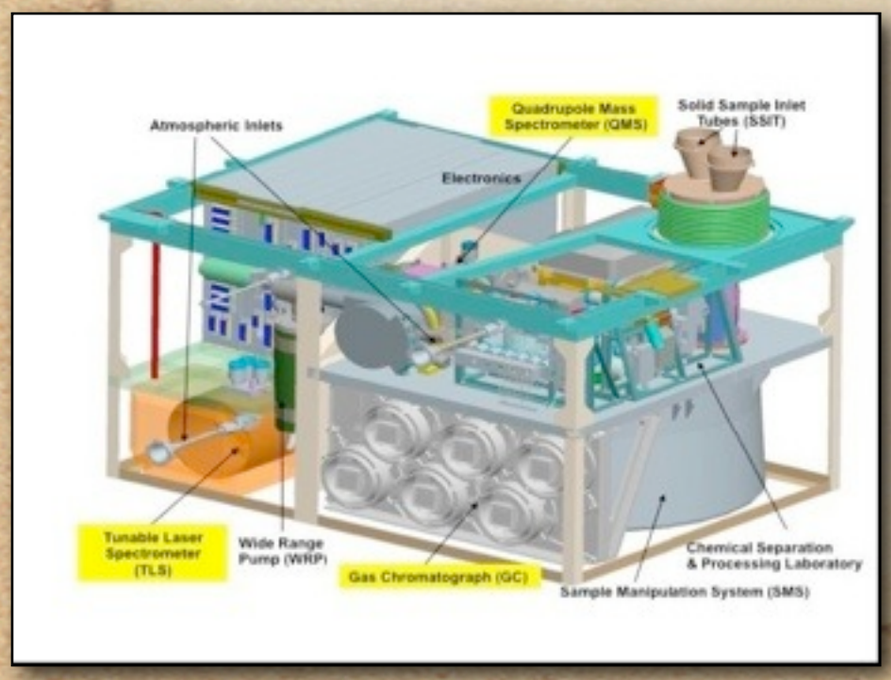
Overview

- Three lessons that are appropriate for classes in Earth science, geology, astronomy, multimedia, or computer literacy.
- These materials fit into national standards for 9-12 grade science.
- Teachers can use all or parts of the lessons and materials.



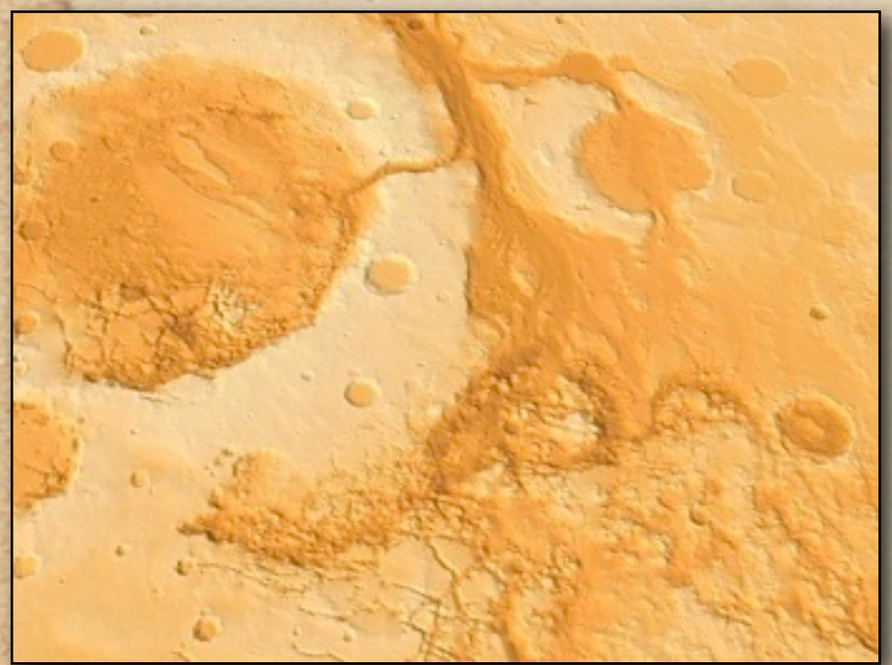


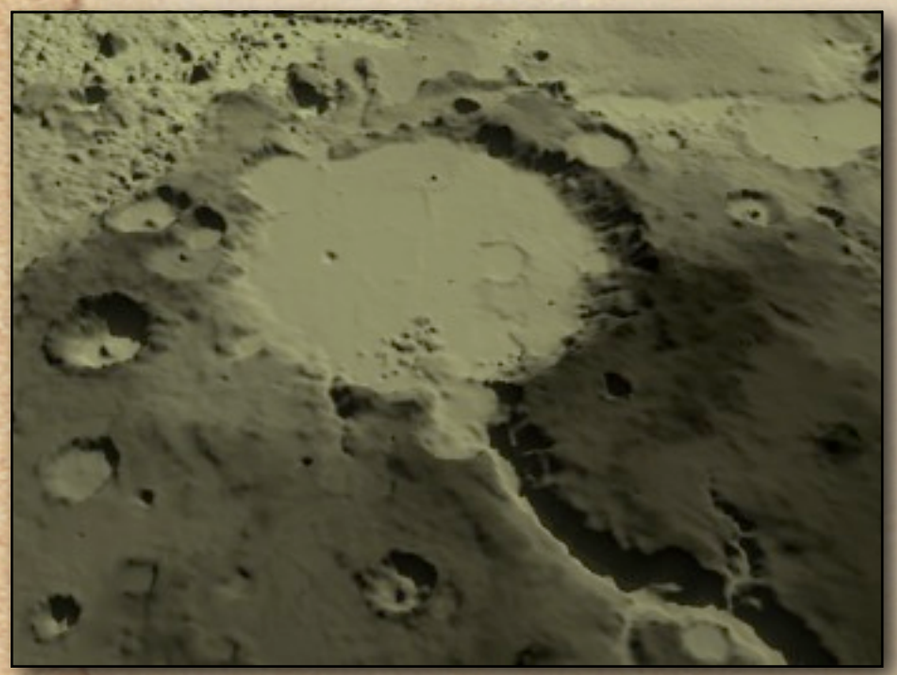


Mars Science Lab (Curiosity)

- Launch window: Nov. 25 - Dec. 18, 2011; lands August, 2012.
- Includes RTG power, advanced robotic arm, laser spectrometer, mass spectrometer, gas chromatograph.
- Will analyze air and soil samples for signs of biological elements (carbon, nitrogen, oxygen, sulfur, phosphorus) and compounds.

1. Mars Site Selection





- Introduces Martian geography.
- Introduces the science objectives of the Mars Science Laboratory (Curiosity).
- Shows how landing sites are chosen collaboratively.
- Teaches students to develop and defend a proposal.

Mars Site Selection

- Student teams take the roles of Mars scientists.
- Entry, Descent, and Landing: Choosing a safe site with a 25 x 20 km landing ellipse.
- Principle Investigator: Site with best payoff of science objectives.
- Power, Mobility, and Communications: Keeping the rover going, how to get to the science sites.
- Project Manager: Final decision and spokesperson.

Mars Site Selection

Final Four Sites:

Holden Crater

Eberswalde Crater

Mawrth Vallis

Also:
Gale Crater

- Teams select a site using online maps and Google Earth, then write a proposal including paths to selected sample locations.
- Project Manager presents proposal; whole class decides on best site.

2. Finding Mars on Earth

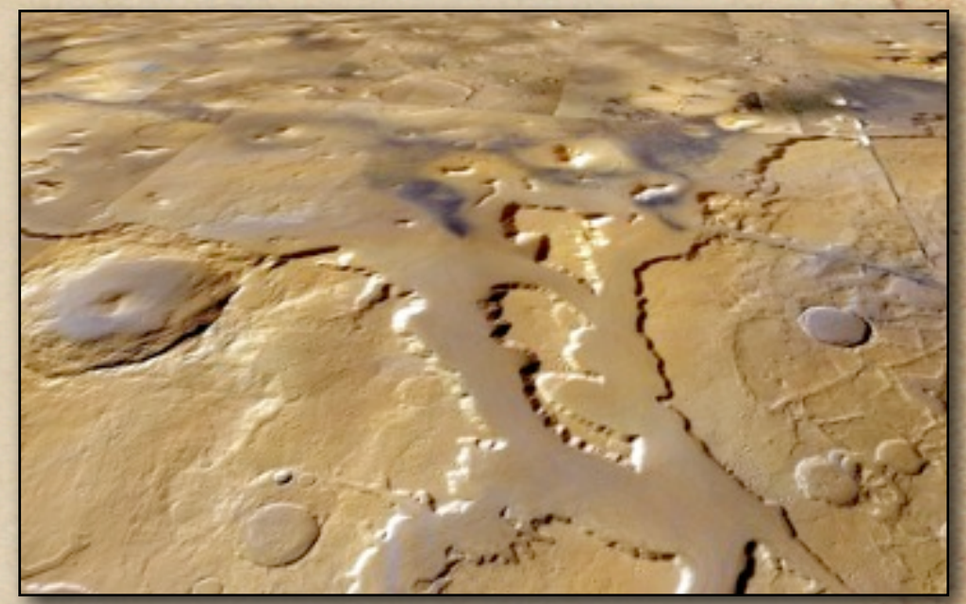
- Mars has an arid climate.
- The Great Basin (UT, NV) is an excellent analog for Mars.
- We can visit Earth sites and observe processes.
- Students will use latitudes and longitudes to examine Earth and Mars analogs in Google Earth.

Finding Mars on Earth

- Students will develop hypotheses about the processes that formed each terrain, based on observations and comparisons.
- They draw conclusions about the presence of long-lasting water at the sites.
- Relates Mars with Earth.

Using Google Earth

- Google Earth is a freeware program.
- You will need to install the program, and be connected to the Internet, to use the search functions.
- Using the trackball and zoom controls in the upper right corner allows a 3D view of the location.

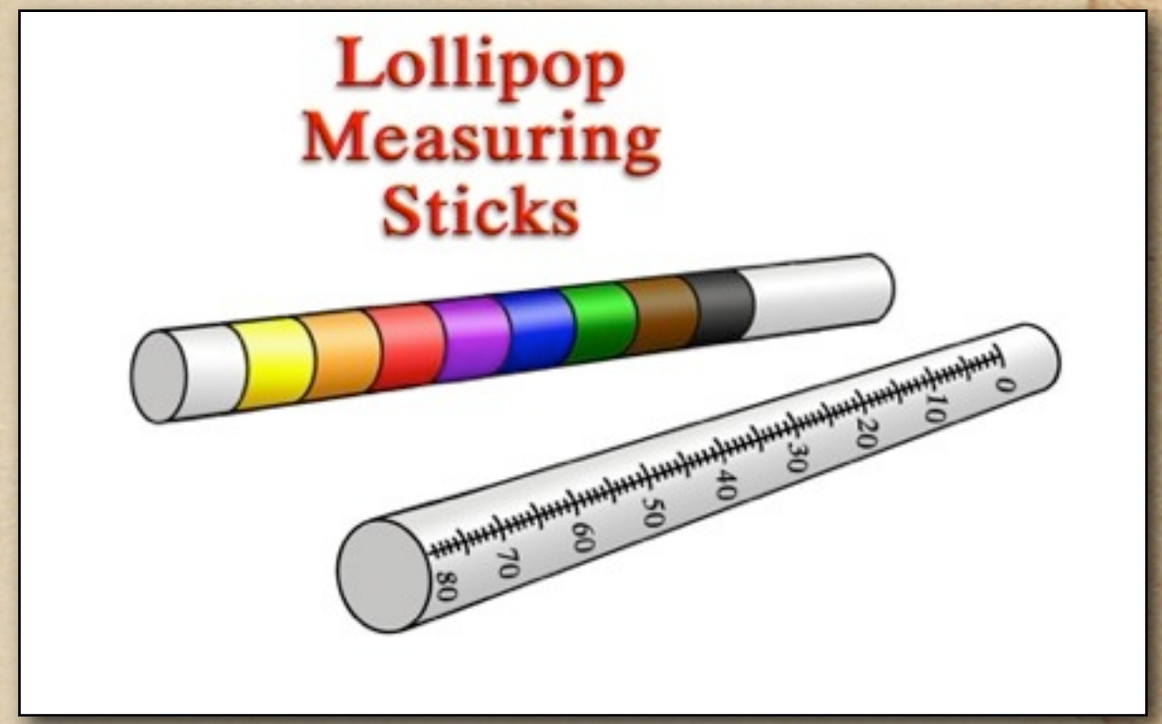


3. From Mars to Model

- Simulates the data collection, analysis, and modeling of the MOLA instrument on Mars Global Surveyor.
- Uses clay or paper maché terrains in a box with a regular grid of holes in the lid.

From Mars to Model

- Popsicle sticks are used to record topographical data (color-coded) and altitude height measurements.
- Scales are reversed so that the height of the mountains (not the depth of the valleys) is measured.

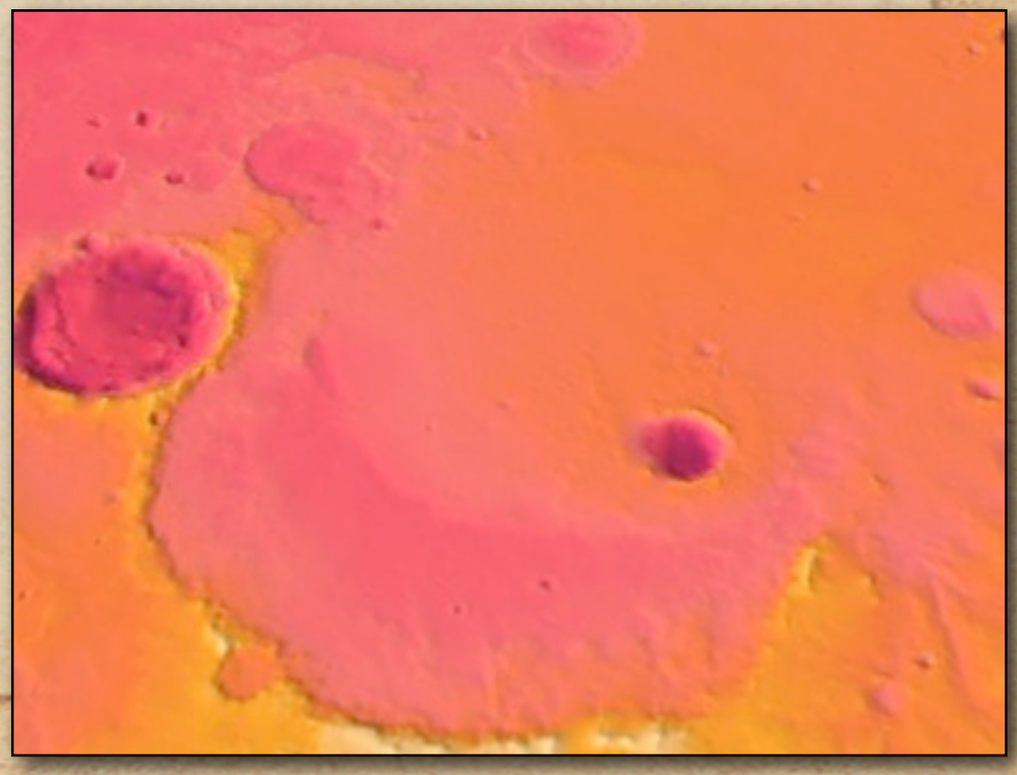


From Mars to Model

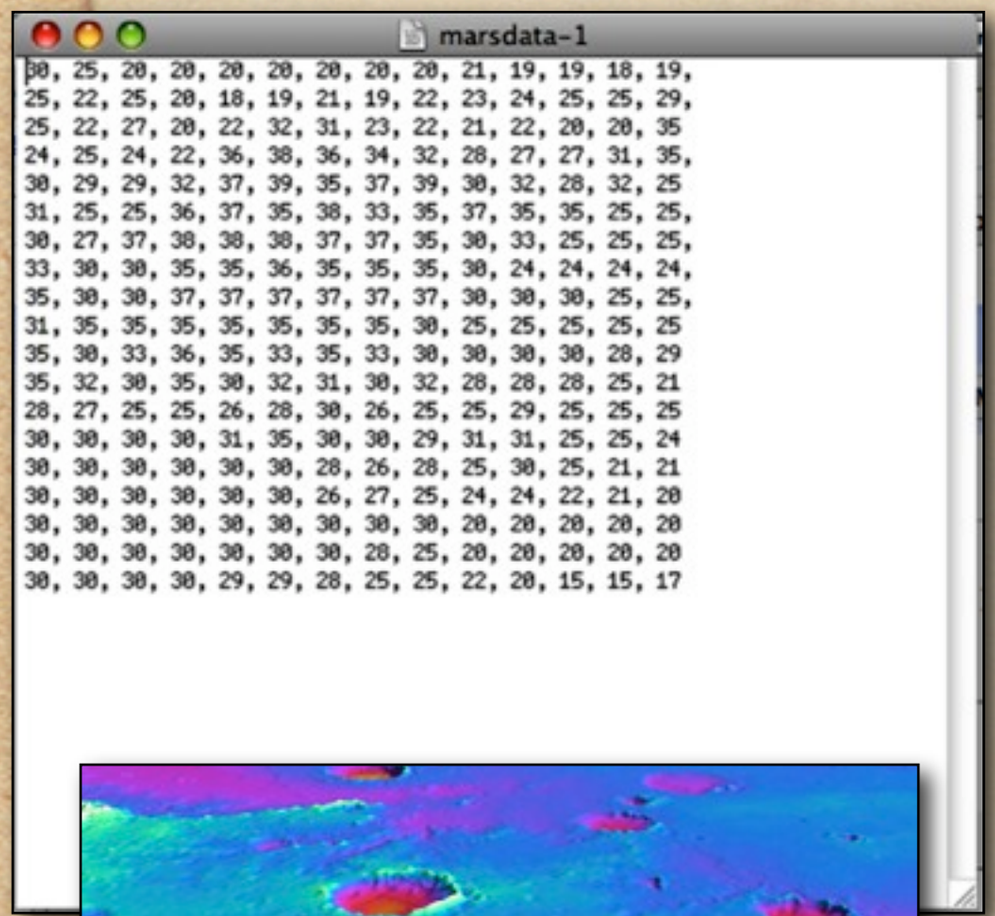
- Three models are created:
- Model A is a direct color-coded topographical model.
- The color seen on the stick is painted into the squares on the paper grid.
- Light colors (yellow and orange) are high areas, dark colors (brown and black) are low.

From Mars to Model

- Model B is a physical model.
- Lengths of drinking straws are cut to match the numeric data (mountain heights).
- These are stuck into a rolled-out layer of modeling clay in the same grid pattern.



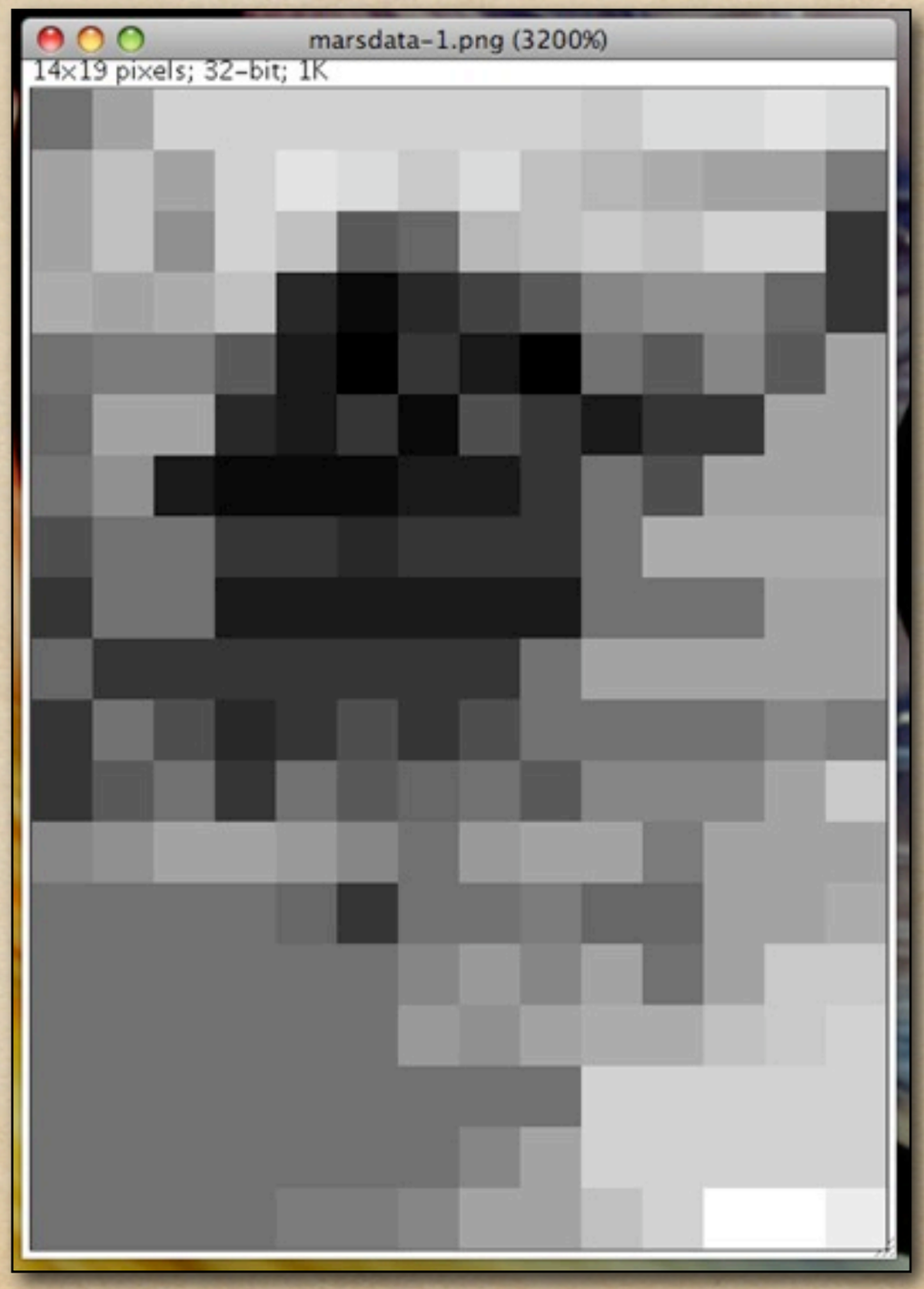
From Mars to Model



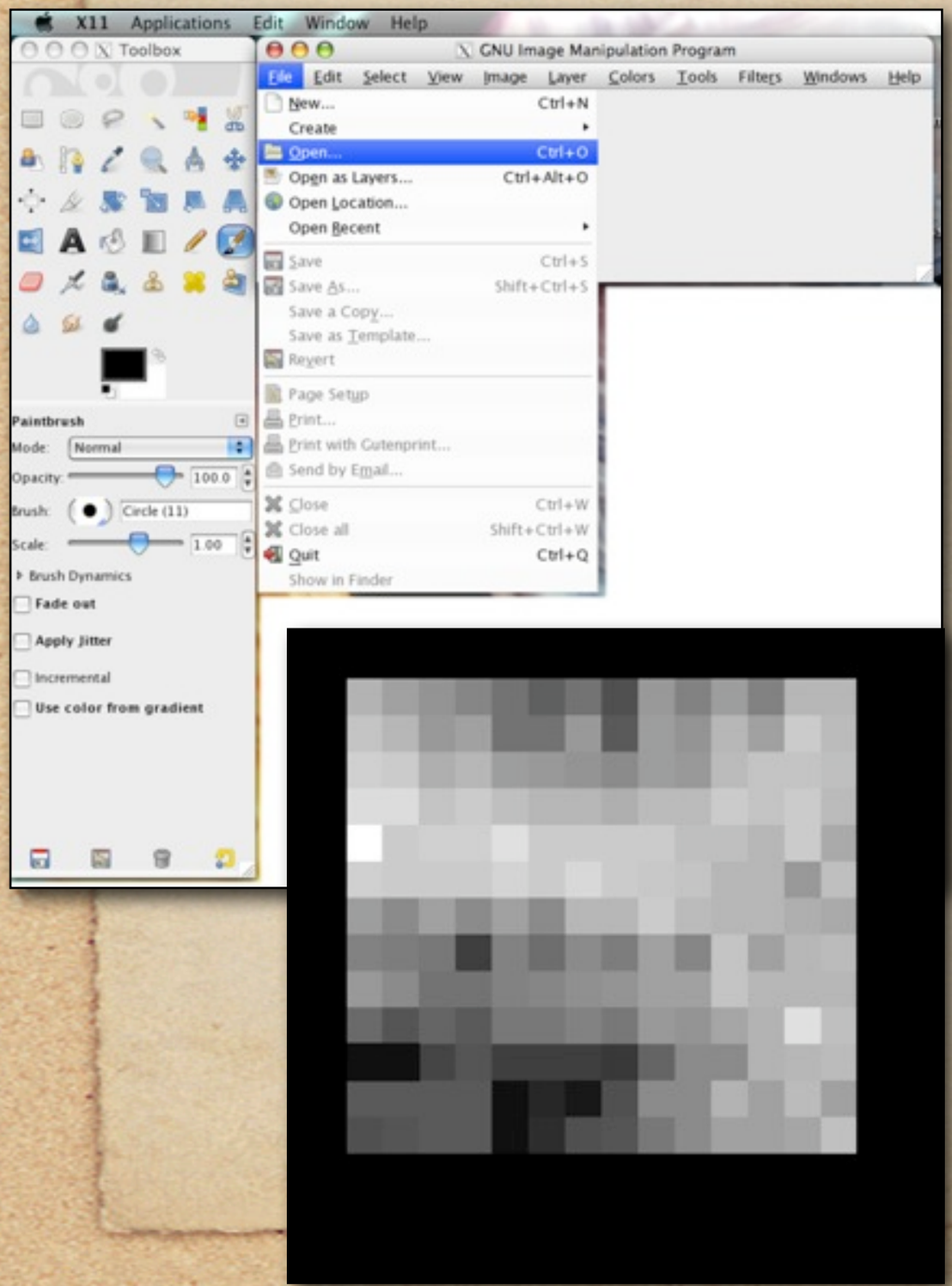
- Model C is a virtual model using 3D software.
- Numeric data is typed in a word processor as a sequence of numbers separated by commas, with a new line for each new row.
- Zeros are added at the start and end of each line.
- The file is saved in .txt format.

From Mars to Model

- The .txt is opened as a text image in ImageJ.
- The small file is zoomed in and saved as a screen capture (Shft-Cmd-3 on Macs, PrntScrn on Windows).



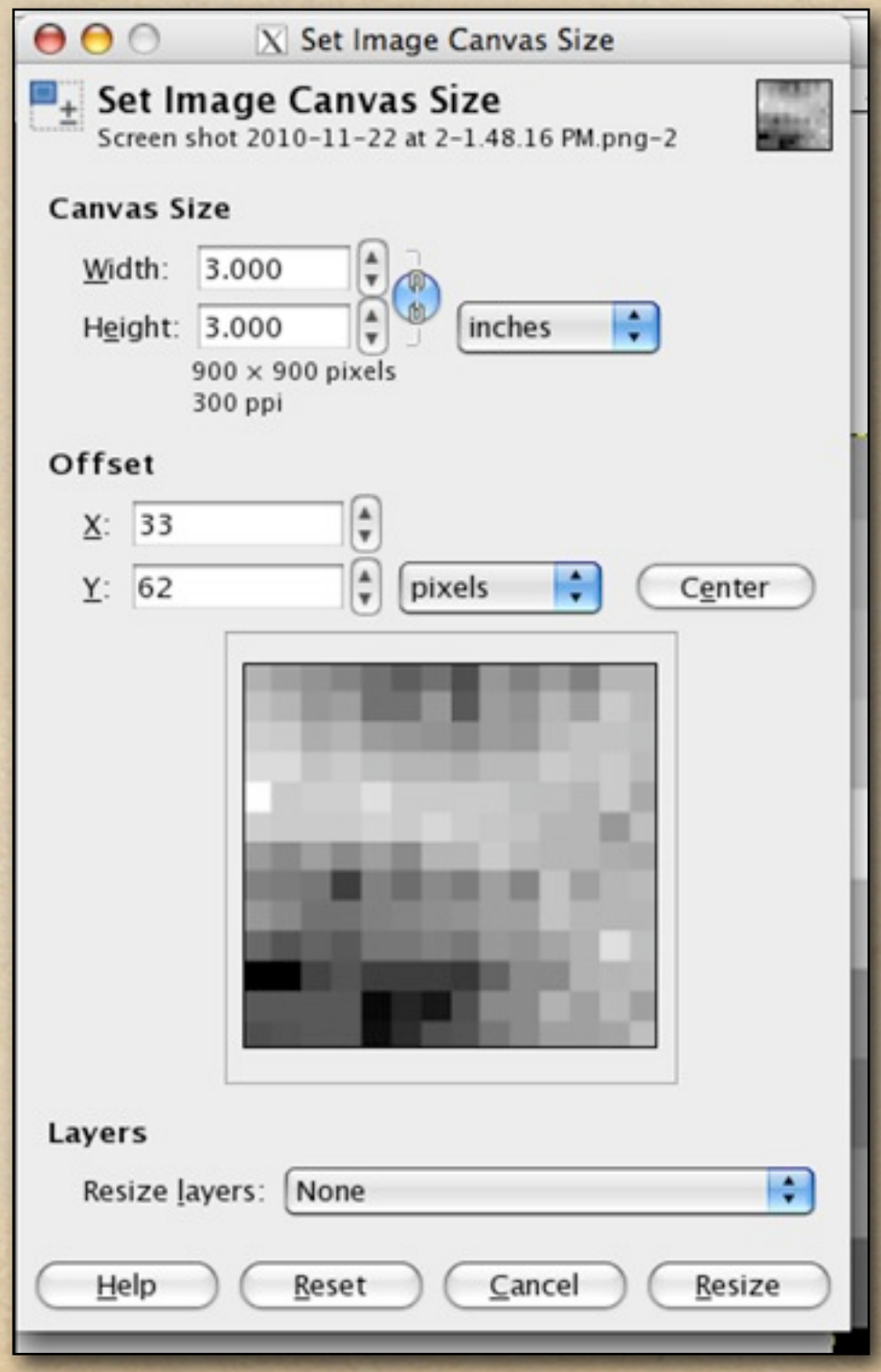
From Mars to Model



- The screen capture is loaded into GIMP (open file and locate Picture 1 for Macs, "File - Create from Clipboard" for Windows).
- Crop the image if needed.
- Increase the image resolution.

From Mars to Model

- Change the canvas size to make the image square.
- Select the area outside the grayscale heightmap and fill it with black.
- Save the file as a high-quality .jpg.



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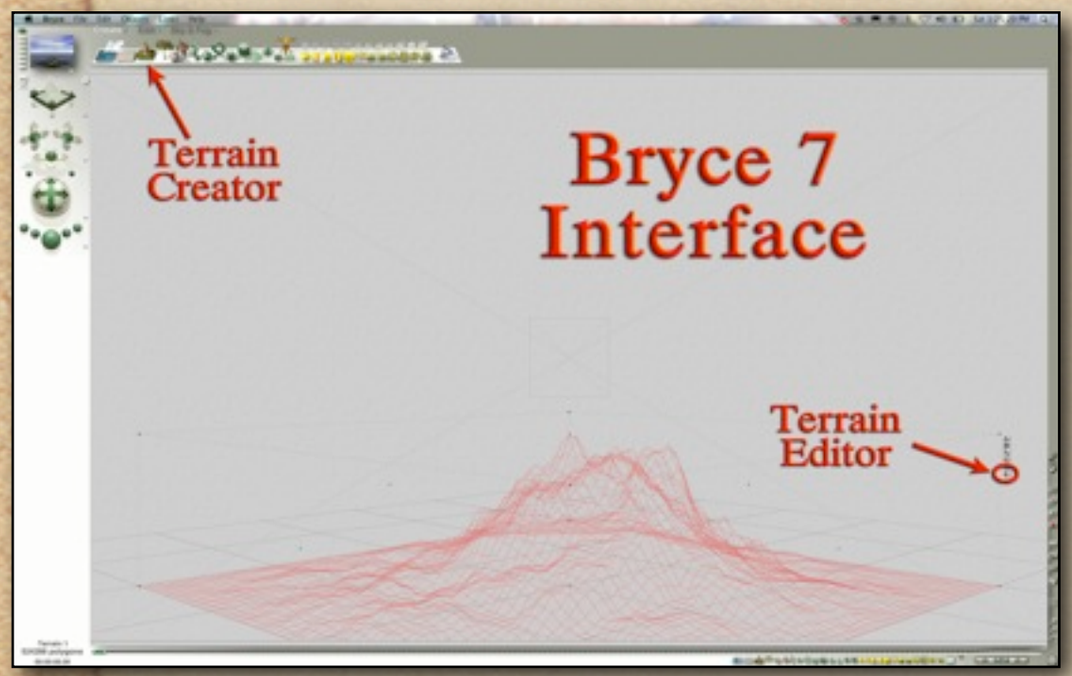
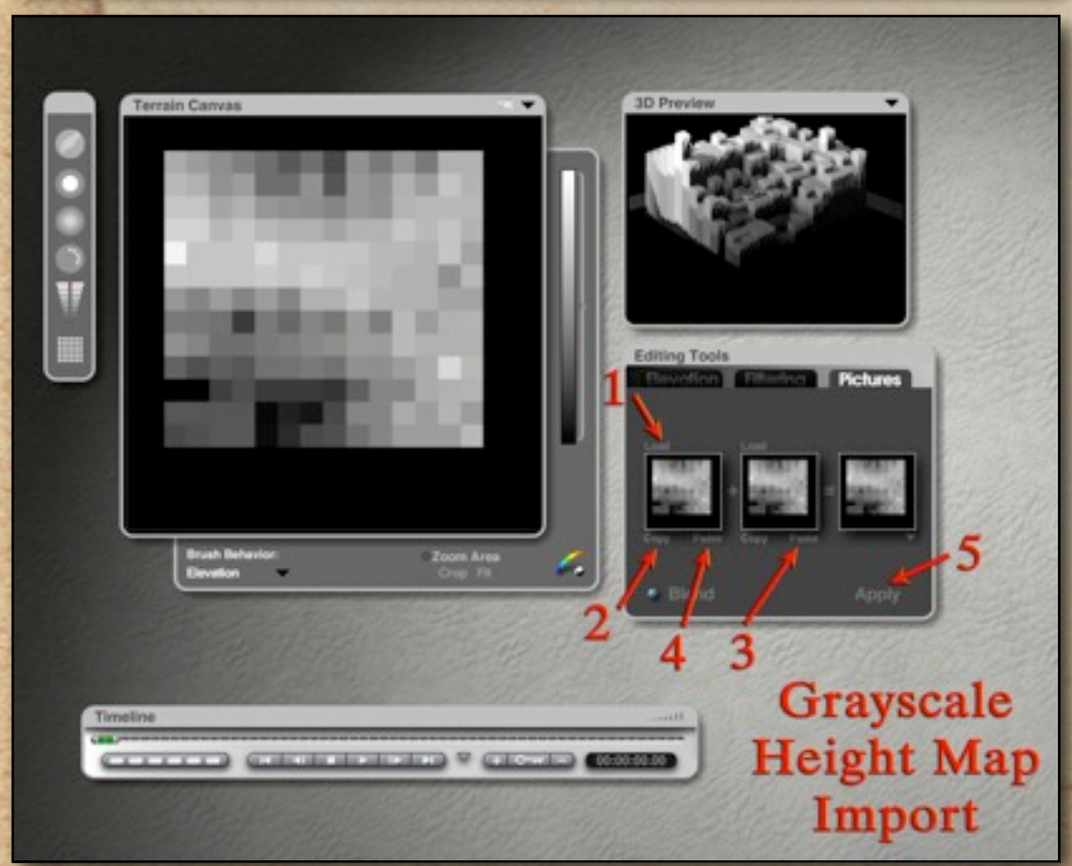
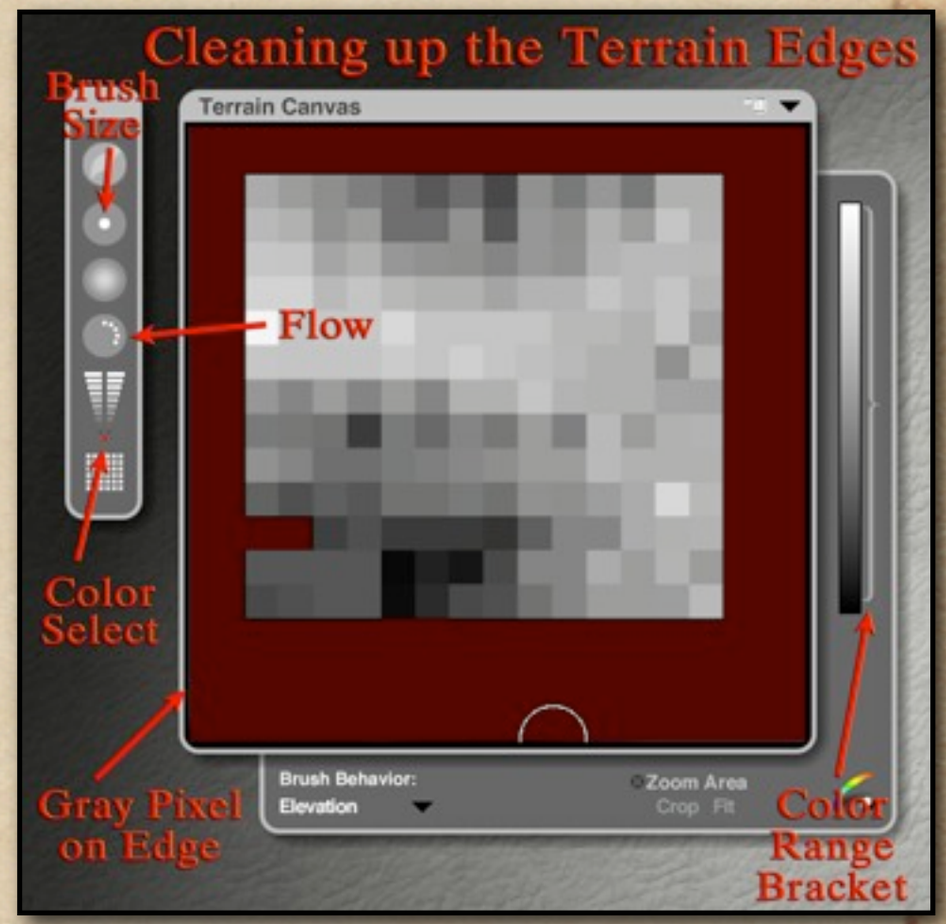




- Open Daz3D Bryce and create a new terrain.
- Open the Terrain Editor and load in the heightmap image (Step 1).
- Copy the image (Step 2) and paste it to the middle square (Step 3), then paste it back into the left square (Step 4).
- Apply the image to the terrain (Step 5).

From Mars to Model

- Make black areas transparent (Color Range Bracket).
- Make the terrain solid, Exit.
- Add a Material to the terrain and to the ground.
- Position the camera and the sun.
- Render the scene and save (Export Image).



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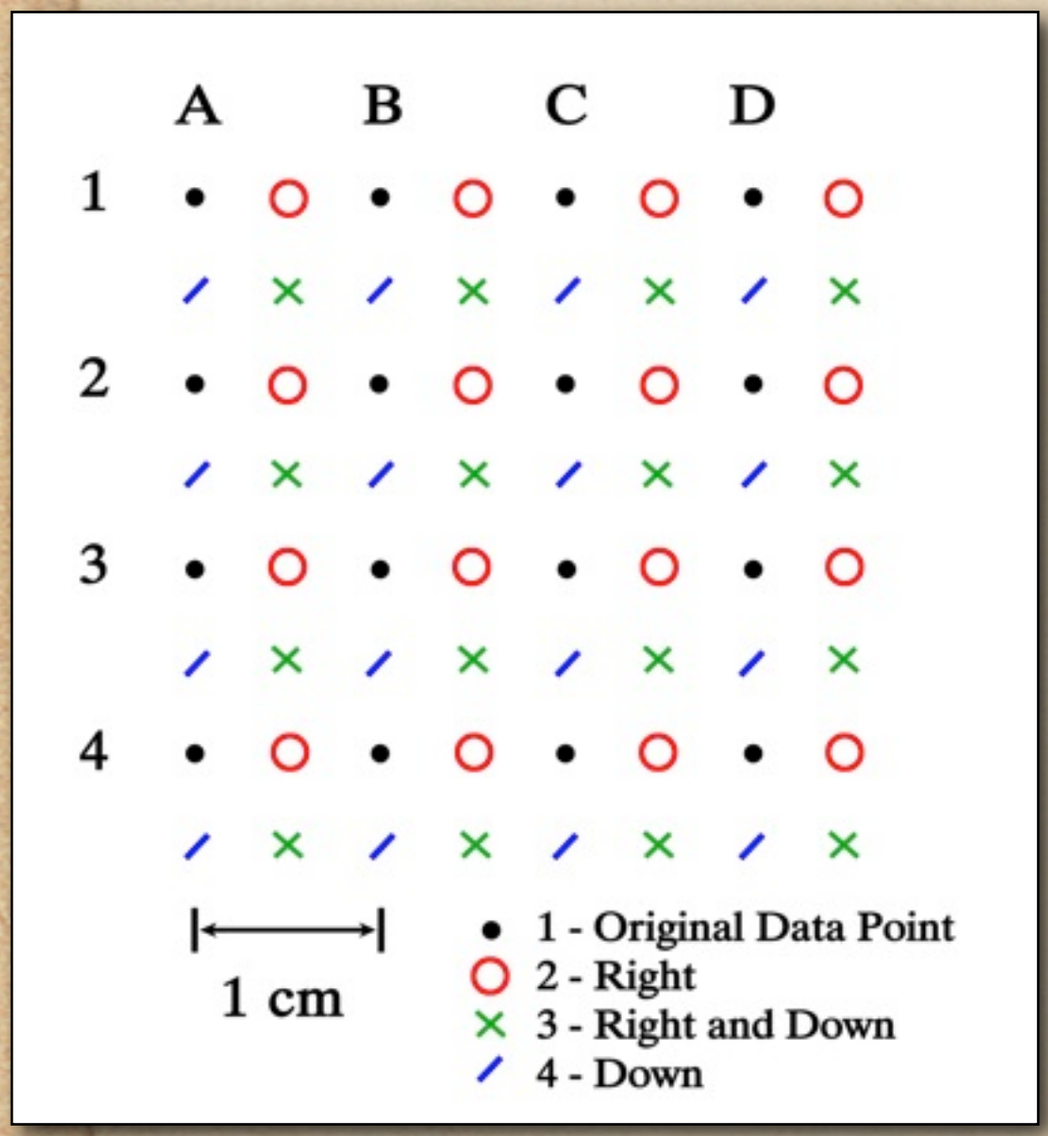
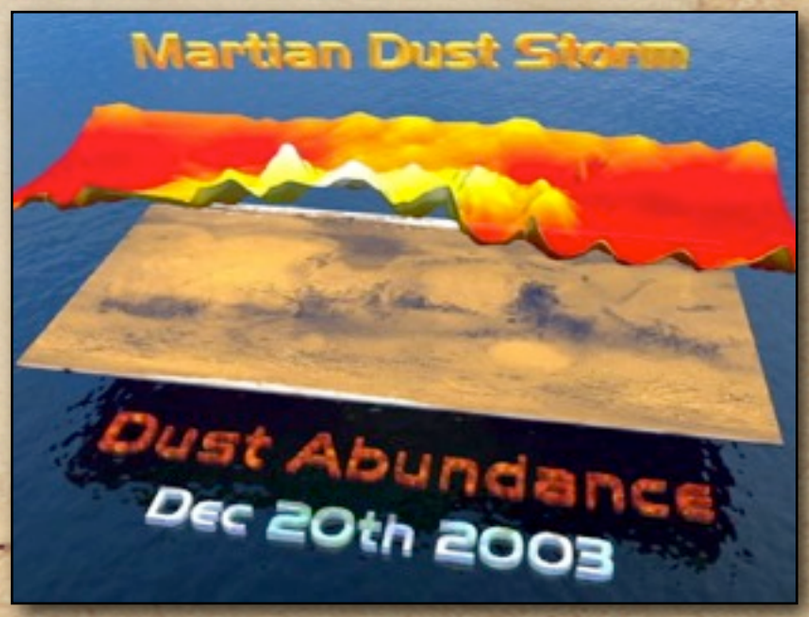


- Increase the resolution of the model by moving the original grid by .5 cm right, then down, then left.
- Collect data points each time.
- You will have doubled your resolution and increased the data size by four times.

Relevance

- Practical Applications: In computer graphics, doubling the resolution means having four times as many pixels.
- The MOLA instrument built up higher resolution through multiple orbits.
- As models contain more data, they resemble the real object more closely.
- Many types of data can be visualized using this method: Numbers to grayscale image to 3D model (Ex: Martian Dust Opacity)



Mars Dust Storm: 2003

Data from Mars Global Surveyor

Part of the Mars Exploration Student Data Team (MESDT) Program